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P6_7 Killer Rabbits: Preparing for Battle

K. Jiggens, J. Antonelli, P. Rojas Guijosa, G. Bower and K. Dhaliwal

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

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Abstract

In the 1975 film "Monty Python and the Holy Grail", we are introduced to a fictional rabbit who has the ability to decapitate and kill humans. Within this article, we explore breeding an army of 100 million of these rabbits on-board a spacecraft for the purpose of invading a habitable planet within the Universe. We discover that it would take a total of 3.6 years to breed this number. We also investigate how far they could travel within a rabbits' expected lifetime, travelling at a velocity of $0.85c$, and the amount of time this voyage would appear to take from the perspective of a stationary observer on Earth. It is calculated that, throughout a period of 7 years, they could cover a total distance of 5.9 light years. This would appear to take 13 years to the stationary Earth observer.

Introduction

During the film "Monty Python and the Holy Grail", King Arthur and his knights arrive at the cave of Caerbannog. This cave turns out to be guarded by a killer rabbit which is shown to be able to decapitate one of the knights in just a split second. We are going to investigate how long it would take to breed an army of 100 million of these rabbits whilst on-board a spacecraft. We will assume that all rabbits are sterilised after the target of 100 million is reached, to prevent further breeding.

Furthermore, we are going to calculate how far these rabbits could travel in their lifetime if the spacecraft has a constant velocity of $0.85c$. We evaluate whether this distance is far enough for the rabbits to reach a habitable planet which they could invade, given the existence of life on the planet. In addition, we will discover how long this journey would appear to take from the perspective of a stationary Earth observer.

Theory

The Breeding - Our breeding process will begin with two newborn rabbits; one of each sex. Firstly, we need to find the time required for the population of the killer rabbits to grow to 100 million. Population growth can be represented by:

$$P = P_0\, e^{r\,t} \tag{1}$$

Where P is the population after time t, P_0 is the initial population and r is the rate of growth. Our first task is to find the time. To do this, we created a computer simulation using Python with the following parameters: a gestation period of 30 days [1], the rabbits require 6 months to reach sexual maturity [2] and each female rabbit produces a litter of 6 comprised of 3 male and 3 female kittens [3]. Our results are shown in figure 1.

By fitting a curve of best fit to our model, we can obtain a value for r from the gradient; 0.41 months^{-1}. From our simulation, we found

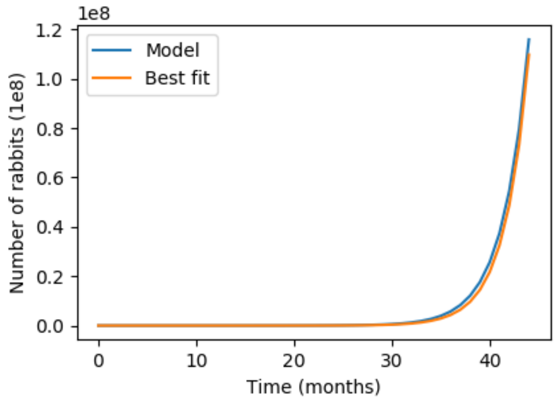

Figure 1: Plot showing the population growth of the rabbits.

that it would take 44 months to breed 100 million rabbits. This translates to 3.6 years.

The Journey - Rabbits have a life expectancy of 8-12 years [4], and will we assume some of our rabbits will start dying once they turn 8. Therefore, we will look at how far they can travel on the spacecraft travelling at a constant velocity of $0.85c$ (where c is 3.0×10^8 ms^{-1}) in 7 years (2.2×10^8 s). By multiplying $0.85c$ by the time, we calculate they will travel a distance of 5.6×10^{16} m. This equivalent to 5.9 light years.

In order to find how long this journey would appear to take to the stationary observer on Earth, we can use the following:

$$\Delta t = \gamma \, \Delta t' \tag{2}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{\nu^2}{c^2}}} \tag{3}$$

Where Δt is the time taken from the reference frame of the Earth observer, γ is the relativistic parameter, $\Delta t'$ is time taken from the rabbits' frame of reference, ν is the velocity of the spacecraft and c is the speed of light.

By substituting in our value for ν into Eq. (3), we calculate that γ is 1.90. We can then find the value of Δt by taking the time lapsed in the rabbits frame of reference (7 years) and substituting into Eq. (2). Hence, for the stationary Earth observer, the rabbits voyage would appear to take 13 years.

Conclusion

We conclude that breeding 100 million killer rabbits would be a challenging task to undertake, as it would entail over 3 years of breeding. It should be noted that this is an idealised situation with each litter containing an even split of male and female kittens.

Also, in the 7 years of travelling, the rabbits could cover a distance of 5.9 light years. This means the rabbit army would be able to reach the nearest habitable planet to Earth, Proxima b, which is 4.22 light years away [5] . Moreover, due to relativistic effects, this journey undertaken by the rabbits would appear to take almost twice as long to an stationary observer on Earth. In addition, travelling at this speed would most likely kill the rabbits and it currently not possible.

To further extend this study, more research into the practicality of having a killer rabbit army can be done. For example, other transportation possibilities.

References

[1] `hhttps://www.pets4homes.co.uk/pet-advice/mating-gestation-and-\\birth-with-small-breed-rabbits.html` [Accessed 2 Oct. 2018].

[2] `http://florida4h.org/projects/rabbits/MarketRabbits/Activity8_Maturity.html` [Accessed 9 Oct. 2018].

[3] `https://www.petplan.co.uk/blog/a-guide-to-rabbit-pregnancy/` [Accessed 2 Oct. 2018]

[4] `https://www.petmd.com/rabbit/care/how-long-will-my-rabbit-live` [Accessed 9 Oct. 2018].

[5] `https://www.space.com/33844-proxima-b-exoplanet-interstellar-mission.html` [Accessed 24 Oct. 2018]